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TECHNOLOGIES FOR TONE- AND COLOR REPRODUCTION BY MEANS OF DIGITAL PRINTING

At this work considers modern technologies of tone and color reproduction by means of digital printing. A generalized classification of tone and color reproduction technologies in digital printing is presented, which reflects the main approaches to quality control according to ISO standards. The main approaches to improving the quality of digital printing are analyzed. The standard scheme of the converting color to the CMYK system is presented and analyzed.

The modern publishing and printing process is characterized by an increase in variety of printed matter and a decrease in circulation. Therefore, the proportion of prints produced by digital printing is constantly increasing. However, the existing standards and standards for quality control of the tone and color reproduction process have been developed for the standard offset printing process. This makes it somewhat difficult to use digital printing for high quality printing products. Corporate editions with color reproduction from the PANTONE color palette are quite complex to reproduce by digital printing [1-3]. For digital printing, the use of color ICC profiles is important, it is part of the control and quality control system for tone and color reproduction. The use of ICC profiles makes it possible to characterize the color parameters of a given device and the requirements for color perception by determining the correspondence with respect to the standard color space. The correspondence between the color spaces can be determined by the conversion tables to which the interpolation applies. The color ICC profile of the digital printing machine in combination with the corresponding inks and paper in accordance with the standards [4] allows to reproduce the tone gradation and the color approximated to the used color palette (PANTONE Formula Guide: Coated & Uncoated for CMYK). ISO standards for quality control of pre-press and printing processes of publishing and printing production are constantly being improved. In particular, over the last 10 years, there has been a shift from quality control of optical imprints to color differences. Also, the latest revisions of ISO standards indicate the features of color control in offset, flexographic, gravure, screen and digital printing [5-6].

On the basis of the analysis of basic ISO standards and industry recommendations [6] on quality control of publishing and printing production, a classification of technologies of tone and color reproduction by digital printing was developed. According to the developed classification (fig. 1) various variants on color of the press are allocated. Quite promising is the use of three-color printing (CMY), which saves on the amount of ink used. In particular, the HP Indigo Digital Printing machines uses the Enhanced Productivity Mode (EPM), which provides CMY inks printing with the exception of K ink [7]. Also, perspective schemes are printing in six or more inks, which allows to significantly expand the color gamut.

According to the presented classification in fig. 1 shows the popular original layout layouts for raster (PS, TIFF, PNG, JPEG, JPEG2000) and vector images (AI, EPS, PDF, IND, QXD).

Types of printed products require the application of various approaches to the quality control of digital printing (fig. 1). In the production of standard publications (leaflets, brochures, photo books), digital printing takes into account the type of paper and “eciRGB” color ICC-profile. For digital printing of fine-art, the FOGRA53 standard and “wide-gamut RGB” color ICC-profile are used. Digital printing of large-format and personalized products requires compliance with the FOGRA39 standard and “eciCMYK” color ICC-profile.

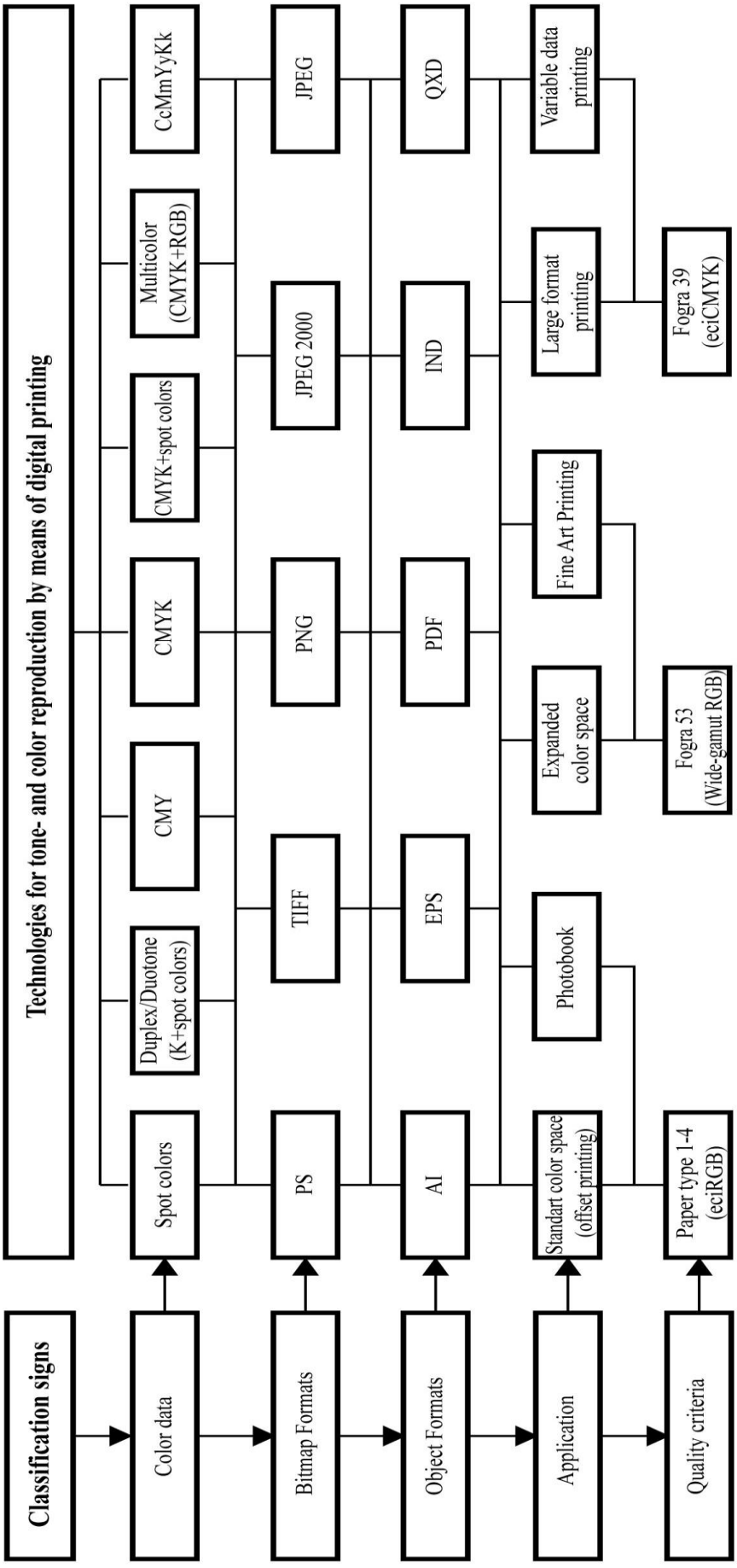

Fig. 1. Classification of technologies for tone- and color reproduction by means of digital printing

The main problem in preparing the layout for digital printing is the process of converting the color gamut from the RGB system to the CMYK system (or other color systems). Two main approaches can be used to convert color gamut: compression and clipping. Each approach has its own varieties. Color gamut compression (rendering intent) can be linear (Saturation) and non-linear (Perceptual). When using clipping of color gamut, the method of color gamut processing including Absolute or Relative colorimetric rendering intent. These methods allow different result for tones gradation reproduction of working CMYK colors.

In the standard conversion of color gamut from the RGB color system to the CMYK system (fig. 2.), the greatest reduction in gradations is inherent in binary colors (red, green, blue), and less for basic triad colors (cyan, magenta, yellow). Thus, the greatest decrease in tone gradations is observed in the green, blue and magenta colors (fig. 2.).

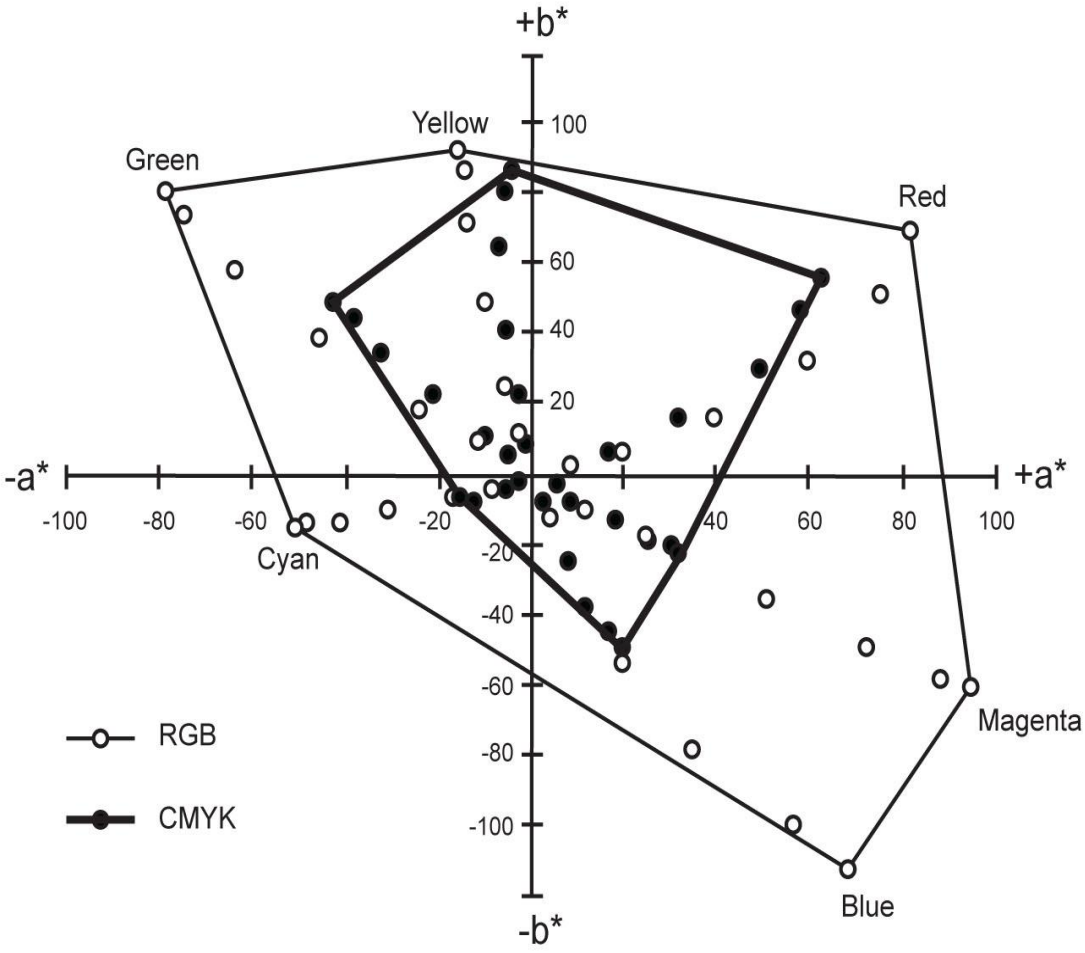

Fig. 2. Standard process of color gamut conversion from RGB to CMYK at CIE LAB system

Consumables (inks and paper) have a great influence on the quality of reproduction of tone and color in digital printing. Therefore, for each combination of ink and paper grade, an ICC color profile is created, which minimizes distortions when converting the original layout into the CMYK system.

Also, when comparing the existing range of supplies for digital printing, one can note the presence of various inks and paper grades, both from the original suppliers and from third-party manufacturers. A study of the color gamut of digital ICC-profiles of such consumables indicates a significant difference in quality. Consumables from official suppliers are characterized by great

stability and color richness. In particular, the magnitude of the color differences at printing by using original and third-party supplies can reach 15–20 ΔE [3].

Consequently, it is possible to improve the color depth and quality of color and color creation in digital printing using the following approaches: using the recommendations of professional standards for reproducing various types of printed products, using a color management system based on color ICC-profiles, using original supplies and increasing the number of inks print.

References:

1. Савченко К. І. Сучасний стан технологій друкування в Україні / К. І. Савченко, О. В. Зоренко, Т. В. Розум, О. М. Величко // Технологія і техніка друкарства. – 2011. – №. 2. – С. 21-27. — DOI: https://doi.org/10.20535/2077-7264.2(32).2011.52761

2. Зоренко Я. В. Исследование качества широкоформатной струйной печати // Тезисы докладов 83-й научно-технической конференции профессорско-преподавательского состава, научных сотрудников и аспирантов, Минск, 1-12 февраля 2017. — URL: https://elib.belstu.by/bitstream/123456789/21500/1/Zorenko_54-55.pdf

3. Кушлик-Дивульська О. І. Дослідження колірних профілів друкарських машин цифрового друку [Текст] / О. І. Кушлик-Дивульська, Б. Р. Кушлик, М. О. Петров // Тези доповідей 6-ї міжнародної науково-практичної конференції «Математика в сучасному технічному університеті». – Київ, 2017 – С.68-71.

4. Домасев М. В., Гнатюк С. П. Цвет, управление цветом, цветовые расчеты и измерения. — СПб.: Питер, 2009. — 224 с.: ил. — (Серия «Учебный курс»).

5. Ковальський Б. Аналіз особливостей нового стандарту для офсетного друку ISO 12647-2: 2013 / Б. Ковальський, Н. Занько, Н. Писанчин // Комп'ютерні технології друкарства. — 2015. — 2(34). — С. 196-204. — URL: http://www.ctp.uad.lviv.ua/images//ktd/34_kovalskiy.pdf

6. BVDM publishes Media Standard Print 2018. Technical guidelines for data, proof and production run printing [Електронний ресурс] // Webmedia 2.0. — URL: https://www.webmedia20.de/en/blog/design/bvdm_published_media_standard_print_2018

7. Режим повышенной производительности (EPM) для цифровых офсетных машин HP Indigo // hpindigo — URL: http://hpindigo.ru/rezhim-povyshennoj-proizvoditelnosti-dlya-cifrovyx-ofsetnyx-mashin-hp-indigo.html